BULLETIN

OF THE

Ohio Agricultural Experiment Station

NUMBER 269 JANUARY, 1914

FORAGE CROPS: ANNUAL GRASSES AND ROOTS

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The word "forage" is used in this bulletin to include those farm crops which are grown for the feeding of livestock and are fed as a whole, either green or dry. For instance: Corn, when it is husked and fed separately as grain and stover, is not considered a forage crop; but when the whole plant is fed as one feed, whether green, dry, or as silage, it is classed as a forage crop.

Our forage crops are found in three principal groups: Grasses, legumes and roots. This bulletin will treat the more valuable annual grasses and roots which have been tested at this Station. The perennial grasses are treated in Bulletin 225; soybeans and cowpeas in Bulletin 237 and, in a future publication, the clovers and some other legumes will be discussed.

In forage crops, as well as in grain crops, corn may properly head the list.

VARIETY TESTS OF CORN FOR THE SILO

For the past ten years the Ohio Station has been testing a number of different varieties of corn for use as silage. It has had difficulty, some seasons, in securing some of the varieties with which work was started and accordingly is able to report work with eight varieties for 5 consecutive seasons only.

TABLE I. Varieties of corn for the silo

Variety	Tons of corn per acre						Percent				Pounds per acre				
	1913	1912	1911	1910	1909	5-year av.	Protein	Crude fiber	Nitrogen free extract	Fat	Protein	Crude fiber	Nitrogen free extract	Fat	Total nutrients
Blue Ridge—Virginia	12.55	20.71	15.52	7 78	15.82	14 48	1 96	6.20	16.23	.50	567 6	1795 5	4700.2	144.8	7389 1
Hickory King—Virginia	12.34	18 43	13.70	7.15	16.56	13.64	2 00	5.50	15.10	.44	545 6	1500.4	4119 3	120 0	6435 3
Pike Co. White—Ohio (U. S. 77)	12.28	16.26	15 85	7.13	12.61	12.83	1 82	5 07	15.56	.39	467.0	1301.0	3992.7	100 0	5935.7
Boone Co. White—Md., (U. S. 119)	12.43	16.26	15 74	6 83	13.43	12 94	2 07	5.78	16.29	.46	535 7	1495 8	4215.8	119.0	6515.0
Boone Co. White—Tenn., (U. S. 138)	12 96	18.14	15.39	6 85	16.17	13 90	1 89	5.65	14.03	.34	525.4	1570 7	3900.3	94.5	6209 0
Boone Co. White—Ohio	10.88	16 98	15.65	8.47	13 01	13.00	2 06	5.73	16.43	.50	535.6	1489.8	4271 8	130.0	6589.7
Darke Co. Mammoth—Ohio	7.26	15.04	13.87	4 86	14.04	11.01	2 28	5.47	18.75	.55	502.0	1204 5	4128 7	121.1	6107.7
Leaming—Ohio	8.43	11.48	12.22	5.09	10.46	9.54	2.43	6.40	20.34	.69	463.6	1221.1	3880.8	131.7	5861 8

Of the varieties reported upon, the Blue Ridge comes from old Virginia. It is a white dent corn with a white cob and is grown quite extensively by the dairymen of northeastern Ohio for silage uses.

The Hickory King also comes from Virginia, though it is grown quite extensively further south as a field corn.

The Pike County White (U. S. 77) is grown extensively in Pike County, Ohio, where it is known as "Woodburn's White."

Three strains of the Boone County White have been used. Two of them have been secured each year through the U. S. Department of Agriculture; one from Maryland (U. S. 119), the other from Tennessee (U. S. 138). The third strain has been secured new each year from southern Ohio.

The Darke County Mammoth is a popular variety of yellow dent field corn from Darke County, Ohio. It is considerably earlier than the above mentioned varieties and usually matures at Wooster.

The Leaming used in this test is an early strain from the son of the originator of this variety in Clinton County, Ohio.

The yields are given in tons of green corn as cut and weighed into the silo. There is no very marked variation in the maturity of the different varieties save in the case of the last two. The Darke County Mammoth and the Leaming being earlier varieties naturally carried less water than the others and their weight per acre is much lower.

For four of the five seasons reported, each variety was sampled the day it was cut and put in the silo and an analysis made by the Department of Chemistry. The method of sampling was to choose a number of representative plants of each variety. These plants were separated into fodder, grain and cob and each part was weighed and analyzed by itself. It is believed that the nutrients can be determined with greater accuracy in this way than by sampling the chopped corn at random. The average analyses of the different varieties for the several seasons appear in the columns giving the percentage composition. The pounds per acre of the different nutrients, as well as the total nutrients per acre, are computed from the 5-year average yield per acre and the percentage composition.

It will be noted that the varieties which might be classed as "field" corn (The Darke Mammoth and the Leaming), i. e., varieties adapted to the growing of grain because they may be expected to come to complete maturity, do not furnish as large an amount of nutrients per acre as the larger and somewhat later varieties. While a ton of this field corn silage will carry much more nutrients

than a ton of the larger, or so-called "silage" corn, an *acre* of it will furnish less nutrients. Attention should be called to the fact that considerably more water will have to be handled with the larger, or silage corn.

The Station does not recommend any particular variety or type of corn for the silo. It endeavors to report its findings impartially, realizing that the needs of individual dairymen differ. In intensive dairying, where it is a problem to secure enough roughage, the silage corn will likely prove more satisfactory. In the corn belt sections where the problem is to take care of the corn crop, the field corn will doubtless be more satisfactory. Silage made from the latter will not call for the purchase of as much concentrates to feed with it as the former.

While the above figures show more nutrients per acre from the later varieties, the mistake should not be made that mere lateness and immaturity are in themselves advantageous. It should be stated that the closer any variety approaches maturity the more nutrients *that variety* will carry. Accordingly the silage varieties should be planted as early as is safe and be left to come as close to maturity as possible. It is undoubtedly possible to go to extremes in the use of large and late varieties of corn for the silo, though it would seem that one might wisely grow varieties somewhat larger and later than he would feel safe in growing for grain only.

Two varieties of corn have been grown in this silage test for the full period of 10 years. One of them, the Leaming, of the field corn type; the other, the Blue Ridge, of the silage type. The latter was not known under the name of Blue Ridge at the beginning of this test, though it has always been secured from the same source and is the same corn.

The yields per acre are as follows:

TABLE II. The Leaming vs. the Blue Ridge

Variety	Tons of corn per acre										10 yr. av.
	1913	1912	1911	1910	1909	1908	1907	1906	1905	1904	
Blue Ridge	12 55	20.71	15 52	7 78	15 82	12 80	15.42	15 25	15 25	15 86	14 79
Leaming	8.43	11.48	12 22	5 09	10 46	7.30	10 55	10 57	11 60	16 45	10.41

The large yield of Leaming corn for 1904 was due to the fact that the Leaming used that year was a late western strain. It would, perhaps, be fairer not to average it in, as for the Ohio Station conditions it would rank with the silage, rather than with the field type. The 9-year average of the Leaming is 9.74 tons per acre.

In this variety test the corn was planted in hills in order that a perfect stand might be secured by thick planting, then thinned to a uniform stand when the corn was 6 to 8 inches high. In field work the Station drills its silage corn.

Fig. 1. Harvesting silage corn

THICKNESS OF PLANTING CORN FOR THE SILO

This Station has been conducting experiments the past 5 years to determine if possible the proper distance apart to drop kernels in drilling corn for the silo. Four different distances have been tested, viz., 4, 6, 10 and 12 inches. A one-horse corn drill with brush feed has been used throughout the test and quite uniform dropping has been secured. The results of this test are given in Table III.

It will be noted that the differences in yield of corn per acre vary widely with the season. In 1909 and 1912 the 4-inch drilling led by a wide margin, while in 1911 and 1913 it was a little behind the 6-inch, and but slightly ahead of the 10-inch. In four of the 5 years the 12-inch planting has given the lowest yield of all.

It is of interest to compare the amount of rainfall for the months of June, July and August for the 5 seasons. It is apparent that it is during the seasons of excessive rainfall (1909 and 1912) that the 4-inch plantings make the large yields. In seasons when the rainfall is short or moderate the lead over the 12-inch planting is less than 1 ton per acre on the average. In so far as tons per acre are concerned the 5-year average yield drops quite regularly from the 4-inch to the 12-inch planting.

TABLE III. Thickness of planting corn for the silo. Variety: Blue Ridge

Kernels dropped every:	Tons of corn per acre						Average percent of				Pounds per acre				
	1913	1912	1911	1910	1909	5-yr. av.	Protein	Crude fiber	Nitrogen free extract	Fat	Protein	Crude fiber	Nitrogen free extract	Fat	Total nutrients
4 inches	13.47	21.25	14.88	9.57	19.53	15.74	1.58	7.03	15.11	.32	497.4	2213.0	4756 6	100.7	7693.6
6 inches	13 87	19.68	15.10	9.18	13.53	14 27	1.48	5.73	12 28	.27	422.4	1635 3	3504 7	77.1	5735.9
10 inches	13 18	17.20	14.68	8.50	14 11	13.53	1.71	5.78	13.47	.34	462.7	1564.1	3645.0	92.0	5878.8
12 inches	12.73	16.17	13.78	8.53	13.15	12.87	1.80	5.98	13.00	.31	463 3	1539.3	3346.2	79.8	5528.3

Comparative rainfall

	1913	1912	1911	1910	1909
June..	0.97	2.21	3.78	2.57	6.44
July.	4.07	7.46	3.36	1.12	4.05
August..	4.75	7 32	5.19	0.95	5.21
Total	9.79	16.99	12.33	4.64	15.70

As in the variety tests, chemical analyses have been made of each lot of corn for 4 of the 5 seasons. The average percentage of nutrients is indicated in the above table and the total pounds of nutrients per acre, based upon these percentages and the 5-year average yield of corn. The thickest planting—the 4-inch—leads in total nutrients, with the 10-inch second, the 6-inch third and the 12-inch fourth.

While these figures favor the 4-inch planting, there is one very serious disadvantage in this very thick planting which should be mentioned, viz., the plants do not stand up well. They are so slender that they lodge badly, thus making it difficult, both to cut the corn, even with a harvester, and to handle the bundles after they are cut. It is quite probable that, one year with another, 10-inch planting will prove most satisfactory.

This Station has not gathered any data upon the use of corn as a dry forage. The data furnished in Table III should, however, be applicable. Since the finer stalks will be consumed more closely than the coarser, it would doubtless be an advantage to plant corn thicker for dry feeding than for silage.

SORGHUMS

Among the annual forage grasses, sorghum probably ranks next to corn. Three types are usually recognized: Saccharine, non-saccharine and broom-corn.

On account of the dryness of its stems, broom-corn is of little or no value as a forage plant. It is grown almost exclusively for the production of seed and brush—a trade term for the material from which brooms are made—and consequently will not be discussed in this bulletin.

Saccharine sorghum is characterized by an abundance of sweet juice in the stalks of the plants. Formerly it was grown chiefly for the production of syrup but now it is utilized largely as forage, it being the best of all the sorghums for that purpose. Agriculturally, the term "sorghum" is often restricted to this division alone.

The stalks of non-saccharine sorghum possess a small amount of juice and, while sweet in some, in other varieties it is more or less sour.

The members of this division are grown chiefly for grain, and for that purpose they are of great value in semi-arid regions where the rainfall is not sufficient for the proper development of corn; but in humid climates, like that of Ohio, they are of minor value for the production of grain and are utilized to a limited extent only as forage.

For the past two years cane has been included in the Station's variety silage test. That it is hardly equal to corn in the production of silage under Ohio conditions is shown by Table IV, only two varieties—Darke County Mammoth and Leaming—falling below it in yield. The relatively high yields for 1912 may be attributed to excessive rainfall and to fertile soil, the test that year being conducted on an alfalfa sod.

TABLE IV Corn vs. cane silage.

Variety	Tons per acre		
	1912	1913	2-year average
Blue Ridge—Virginia	20.71	12.55	16.63
Hickory King—Virginia	18.43	12.34	15.38
Pike County White—O. (U. S. 77)	16.26	12.28	14.27
Boone County White—Md. (U. S. 119)	16 26	12 43	14.34
Boone County White—Tenn. (U. S. 138)	18.14	12.96	15.55
Boone County White—O,	16 98	10.88	13 93
Darke County Mammoth—O	15.04	7.26	11.15
Leaming—O.	11.48	8.43	9.95
Cane	13.91	11.95	12.93

From time to time, for the past 13 years, a few of the older and more common varieties of sorghum, both saccharine and non-saccharine, have been grown on the Station farm, and from the yields of green forage, which are tabulated in Table V, it is possible to formulate some idea as to their relative value when grown under Ohio conditions.

TABLE V. Sorghum: Tons of green forage per acre.

Year	Variety					
	Saccharine		Non-saccharine			
			Kafir		Durra	
	Amber	Orange	Red	White	Yellow milo	White
1901	11.7	....	9.7	10.7	7.6	...
1902	13.2	....	10.4	10.9	4.9	5 8
1903	8.3	12.7	....	....	8.9	3.9
1905	13.4	17.2	10.1	12.8	...	...
1911	16 2	...	...	12.1	8.3	...
1912	6.2	10.7	5.9	6.9	4.9	...
1913	11 9	15.2	9 8	10.6	7.9	...
Average	11.6	13.9	9.2	10.7	7.1	4.8

Though there are several varieties of saccharine sorghum, only two—Amber and Orange—have been grown at Wooster.

Amber: On the Station farm, Amber attains a height of 7 to 10 feet; has a moderate number of leaves and matures in ample time for the production of forage of good quality. The seed head or panicle is black and more or less open. (Fig. 2.)

Orange: As compared with Amber the Orange is taller, coarser, more leafy, later in maturity and in those years in which both have been grown, the yield of Orange has exceeded that of Amber—the excess ranging from 2.5 to 4.5 tons per acre. The coarseness of the stalk renders it more difficult to cure and hence less desirable than Amber as cured forage. The seed head or panicle is more compact and as it approaches maturity it takes on an orange color, hence the variety name. The greatest usefulness of this variety in Ohio is in the central and southern parts of the state. (Fig. 3.)

Fig. 2. Amber cane.

Non-saccharine sorghum embraces several divisions, the most common, and the only ones, representatives of which have been grown on the Station farm, are Kafir and Durra;[1] the former being characterized chiefly by erect, the latter by recurved heads.

Kafirs: In appearance the chief difference in the varieties of kafir is in color of seed and hull. At this Station only two varieties have been grown—Red and White—these having red and white seeds, respectively. While the Red grows taller (its height averaging 6 to 7 feet), and matures somewhat later than the White, it is more slender and at this Station has yielded a trifle less forage, though the difference is not significant. (Figs. 4 and 5.)

Durras: Of the durra group the variety of most importance which has been tested at this Station is Yellow milo or Milo.

[1]Among other renderings are such as dura, durrah, durrha, dourah and doura.

Compared with the kafirs it matures earlier and yields less forage but in the production of grain it is said to excel all the other sorghums. (Fig. 6.)

White durra, sometimes called "Jerusalem corn" is a durra of minor importance, which when grown on the Station farm several years ago, attained a height of 3 to 5 feet and yielded as an average of two years at the rate of 4.8 tons of green forage per acre.

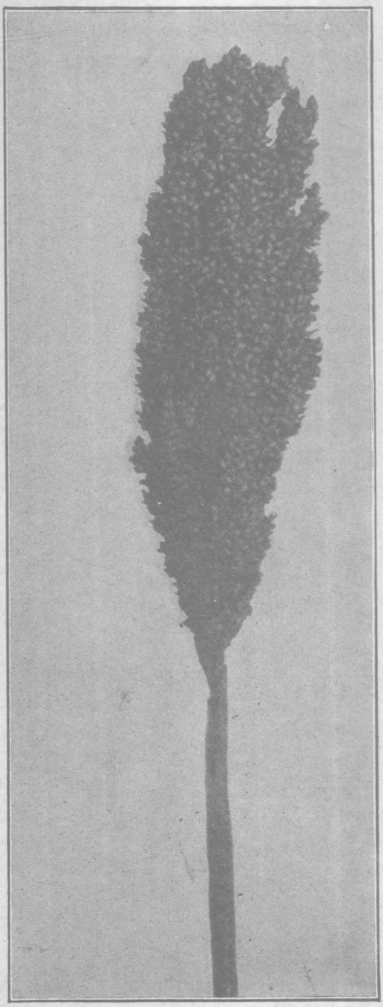

Fig. 3. Orange cane.

Feterita, another member of the durra group and a rather recent introduction from Egypt was grown on the Station farm one year, 1912, and of dry forage it yielded a trifle more than the German millet (one of the best) and considerably less than such sorghums as Amber and Orange cane.

Teosinte: Though belonging to a different species (Euchlaena mexicana), teosinte is so similar to sorghum in its cultural requirements that mention of it may be made here. It is a great stooler and in appearance resembles Indian corn.

In the South, on rich soil, where seasons are long and hot, and where there is an abundance of rainfall—conditions essential for its proper development—it is said to grow 10 to 12 feet high and to yield as high as 50 tons per acre of green forage which is highly prized both for soiling and for silage.

As a source of succulent feed in Ohio it is inferior to both corn and sorghum. On the Station farm it usually attains a height of about 5 feet.

CULTURE OF SORGHUM

Soil: The soil requirements for sorghum are much the same as for corn. On rich land, or with the liberal use of fertilizers on poor land, the yields are increased in the same proportion as are those of corn.

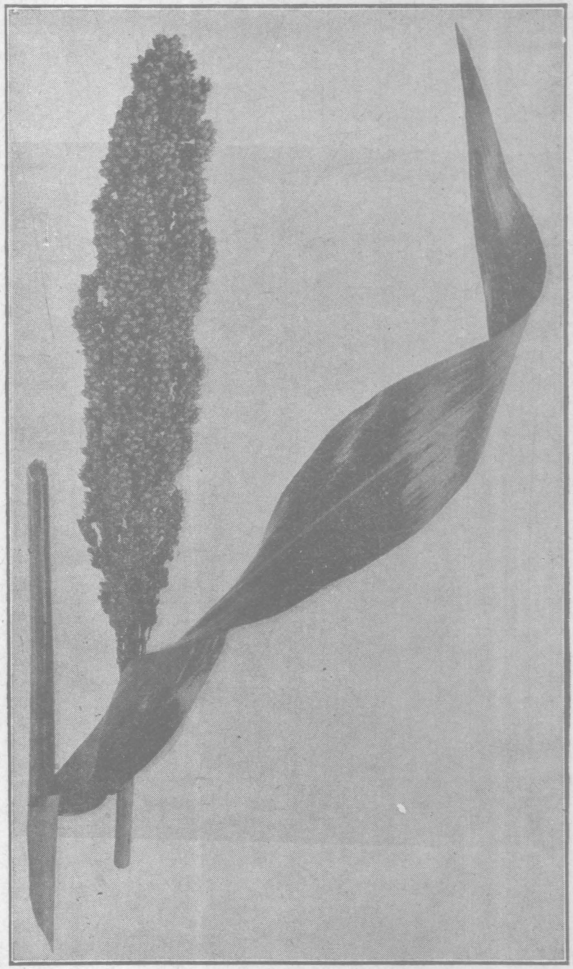

Fig. 4. Red kafir.

Since it is rather shallow rooted, and since it makes its growth in a comparatively short length of time it seems to exhaust, at least temporarily, the available plant food in the surface soil, hence its reputation of being "hard on the land."

Seed bed: The preparation of the seed bed is similar to that for corn. However, since the growth of the young plants, especially for the first few weeks, is very slow, a seed bed strictly clean, well packed and in good tilth, is desirable, else the young plants may be overwhelmed with weeds.

Seeding: In order to encourage a more rapid growth, seeding is best deferred until the ground is thoroughly warm, which, in the latitude of Wooster, is about June 1.

Fig. 5. White kafir.

Sorghum may be broadcasted or drilled solid, using about 1 bushel per acre, thus producing quite a fine quality of hay, or it may be drilled in rows 36 to 42 inches apart, using 8 to 15 pounds of seed per acre and cultivating the same as corn. When wanted for soiling or silage the latter is the more common method.

The seeding may be done by the use of special plates in the corn planter, or the regular plates may be adapted, if necessary, by filling the holes with lead and subsequently boring new ones of the desired size. By stopping part of the hoes, a grain drill may be used.

Cultivation: During the period of its comparatively slow growth, especially if the sorghum is drilled solid, the use of a light harrow or weeder is important. It is advisable to drive parallel with, rather than across the rows. Later cultivation should be the same as for corn—frequent but shallow.

HARVESTING

Silage or fodder: For silage, sorghum is best harvested when the seed is in the dough stage, using an ordinary corn binder. A more bitter silage results from earlier cutting and loss of nutrition from later cutting, as mature seed may pass through animals undigested. Its tendency to ferment renders it more difficult to keep than corn, but when well preserved its feeding value is not much inferior to that of corn.

If, instead of silage, it is utilized as dry forage, the small bundles may be set up and securely tied in moderate sized shocks and fed from the field; or when it is dry—say 4 or 5 weeks after cutting—it may be hauled to the barn and stacked.

Having finer as well as more juicy and palatable stems, the dry forage is equal, if not superior to corn.

Soiling: For soiling, sorghum may be cut at any time after it is large enough to handle nicely, though to best advantage from the time it blooms until towards maturity. As a soiling crop, sorghum is consumed more closely than corn and its resistance to drought makes it a valuable crop for the production of succulent feed during the hot, dry months of summer.

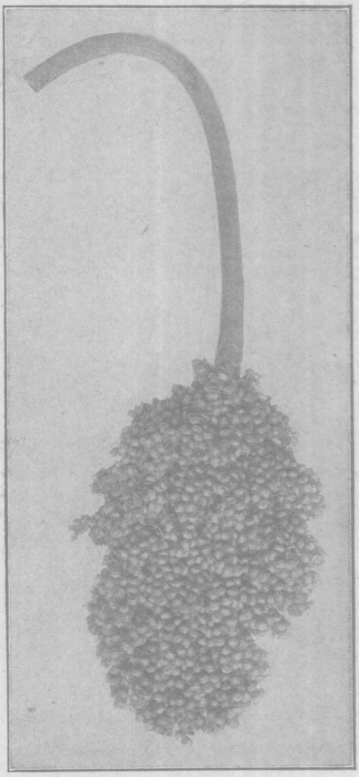

Fig. 6. Yellow milo. Three-eighths natural size

Hay: For hay, sorghum may be cut at any time after heading, though for best quality it should be harvested shortly after blooming. A mowing machine may be used, setting it to cut as high as possible. On account of the succulence of the stems it should be allowed to lie in the swath for several days before cocking and should be thoroughly dry before stacking.

It may be expected to yield from 4 to 8 tons of dry forage per acre.

Pasture: Some danger attends the pasturing of sorghum due to the development of hydrocyanic acid when the growth is checked as by drought or frost. After poisonous sorghum is cut and allowed to wilt, it is said to be fed with little or no danger. Bloat sometimes results from pasturing cattle or sheep on sorghum.

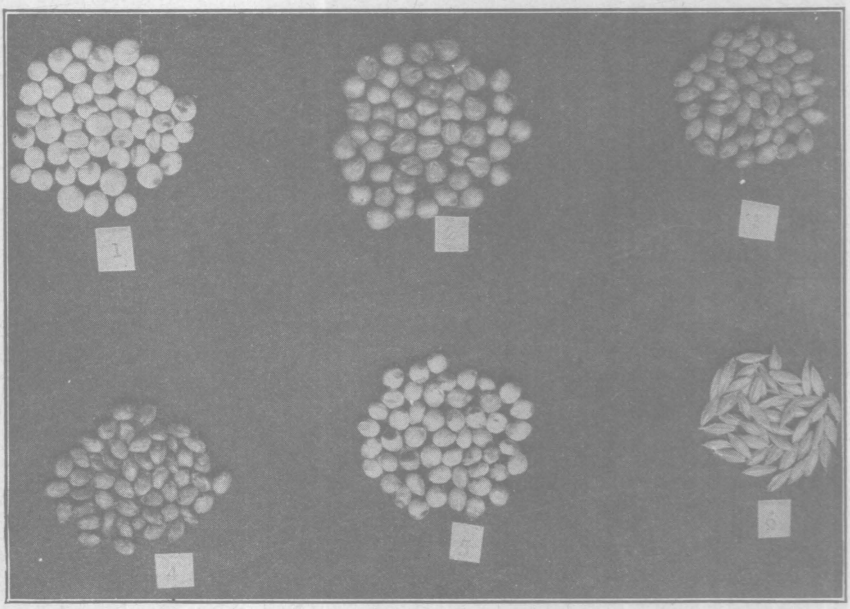

Fig.7. Sorghum seeds. (1) Feterita, (2) Milo, (3) Amber, (4) Orange, (5) White kafir, (6) Sudan grass (unhulled). Natural size.

SORGHUM AND COWPEAS

To get a better balanced feed, cowpeas are sometimes grown with sorghum, either seeding in rows and cultivating, using about 1 peck of each per acre, or seeding solid, using about 4 pecks of cowpeas and 3 pecks of sorghum per acre, After cutting, this mixture should lie in the swath a few days and then be put into cocks where it may remain for a considerable length of time.

At this Station, this combination has been tried several times, but always with unsatisfactory results. The sorghum, though fine, and attaining a height of 4 or 5 feet only, has usually choked out nearly all of the cowpeas, the few remaining being small and of little consequence. A mixture of Amber cane and New Era cowpeas yielded in 1911 and 1913, 6.8 and 14.8 tons respectively of green forage per acre.

MILLETS

The millets constitute another group of valuable forage crops. This is a general term applied to a great variety of cereal and forage grasses, differing widely botanically, but having this in common: All are rapid growing annuals, useful either as green or dry forage, and thriving best in midsummer.

USES

Millet is not usually looked upon as a regular staple crop, occupying a definite place in a fixed rotation, but rather as a substitute or emergency (catch) crop; one to be used in case of failure of clover or alfalfa or in case of the destruction by hail or otherwise of some crop like corn or potatoes.

Often, however, it is seeded not as the result of some seasonal catastrophe, but on account of its adaptation to some particular end. In the case of more intensive farming where two crops per year are desired, it is frequently seeded after the removal of a crop of rye or oats and pea hay. It enjoys quite a reputation as a weed eradicator and under favorable conditions as regards climate and soil, few weeds are able to cope successfully with a thrifty crop of millet. For this purpose it is second only to a summer fallow.

Under Ohio conditions millet is utilized almost exclusively as forage; largely as hay, but to a small extent also as a silage or soiling crop.

In some sections certain varieties are grown for the production of seed.

VARIETIES

A common grouping of the more familiar sorts is foxtail (Chaetochloa italica), broom corn (Panicum miliaceum) and barnyard (Panicum crus-galli).

Representative varieties of all these divisions have been grown by the Ohio Station in a small way, the results of which are reported in Table VI in terms of dry forage or hay.

TABLE VI. Millet: Tons of dry forage per acre.

Group	Variety	Year							
		1904	1905	1908	1909	1911	1912	1913	Av.
Foxtail	Hungarian	3.9	3.4	2.6	2 8	..	2.2	1.9	2.8
	German	5.1	6 1	...	4.8	6 6	3.5	4 6	5.1
	Red Siberian	3.8	3 0	...	3.4	3.9	2.1	3.0	3.2
Broom corn	Broom corn	...	...	.	...	5.4	2.3	1 9	3.2
	White French	5.1	4.4	2.6	2.4	4 7	2.3	1 5	3 3
	Early Fortune	...	...	...	...	0 6	2 0	1.5	1.4
	Black Voronezh	...	...	...	...	0.9	2 2	...	1.5
Barnyard	Japan	6.4	5.9	3 8	6.3	9.2	4.5	4 6	5.8
	Sudan Grass	...	...	...	...	...	3.9	4.3	4.1

Foxtail Millets: For Ohio conditions the most useful group of millets is the foxtail—characterized by an inflorescence or head of a single spike—and the varieties most highly prized are the Hungarian and German. For land in a poor state of fertility, or on richer land in the northern part of the state where the seasons are comparatively short, the Hungarian is preferable to the German, the latter being specially adapted to long seasons and to rich, river bottom land.

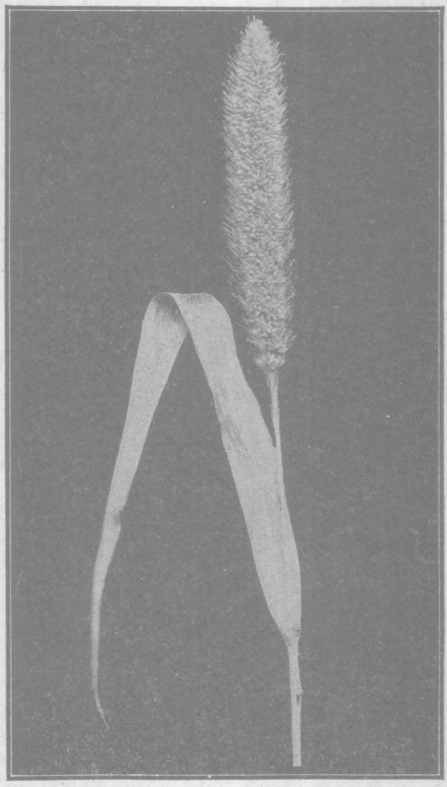

Fig. 8. Hungarian millet. Two-thirds natural size.

The Hungarian millet, or grass, as it is sometimes called, produces from each seed several slender and more or less branched stems upon which are borne rather narrow, dark green leaves and a short, nearly erect, bristly, compact and dark purple head. (Fig. 8.) The seeds are in part purple and in part yellow, the color of the latter possibly being due to immaturity.

The German is a rather coarse, vigorous growing variety, usually producing but one stem from each seed and that not branched. The leaves are somewhat short and broad and the nodding head consisting of clustered branches armed with purplish awns, may be an inch in diameter, 6 to 10 inches long, and bears small yellow seeds. (Fig. 9.)

The Red Siberian is somewhat earlier than the German. As it approaches maturity the heads take on a golden tinge. The color of seeds is a mixture of red and yellow, red predominating.

Broom corn millets: In this group of millets the head is a panicle like that of broom corn, hence the name. (Fig. 10.) They are grown for both seed and forage, chiefly seed, but in Ohio, and even in the United States, their culture is not general, it being restricted

largely to Europe. However, in the northwest, in hot, dry seasons, these millets are frequently seeded as a substitute for corn, for the feeding of hogs, hence the common appelation of "hog millets."

Compared with the foxtail group, the broom corn millets are usually shorter, coarser and seeds are larger and of more varied color—white, yellow, red or nearly black.

Of the varieties of this group tested at this Station, the Broom corn and White French are the most useful. In appearance and habit of growth these two varieties are quite similar but in color of seeds they differ; the Broom corn having yellow; the White French, white seeds.

The Early Fortune and Black Voronezh are smaller and earlier forms and, in Ohio at least, are quite inferior to either the Broom corn or White French. The Early Fortune has purplish hulls with yellow seeds; the Black Voronezh white hulls and blackish seed.

Barnyard millet: This is another name applied to the common barnyard grass—a plant of quite universal distribution and of varied size, form and color in different sections of the country (Fig. 11.)

The most useful strain of this species—a variety oftenadvertised in seed catalogues as "Billion Dollar Grass"—is one

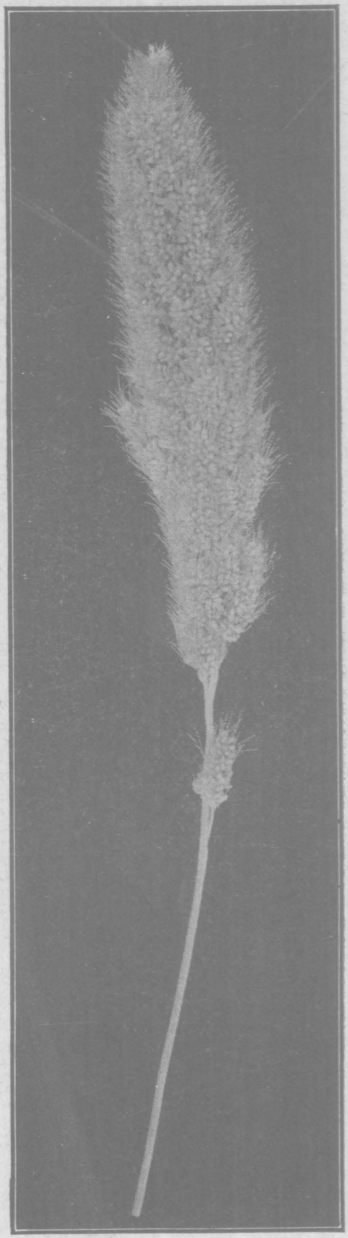

Fig. 9. German millet. Two-thirds natural size.

imported several years ago from Japan by the Massachusetts Experiment Station. According to the findings of that institution it may be regarded as useful for silage and soiling, but unsatisfactory for hay.

While this millet has surpassed in yield of dry forage all the other varieties tested at this Station, the quality of the hay is such, at least under Ohio conditions, that it cannot be recommended in preference to the members of the foxtail group.

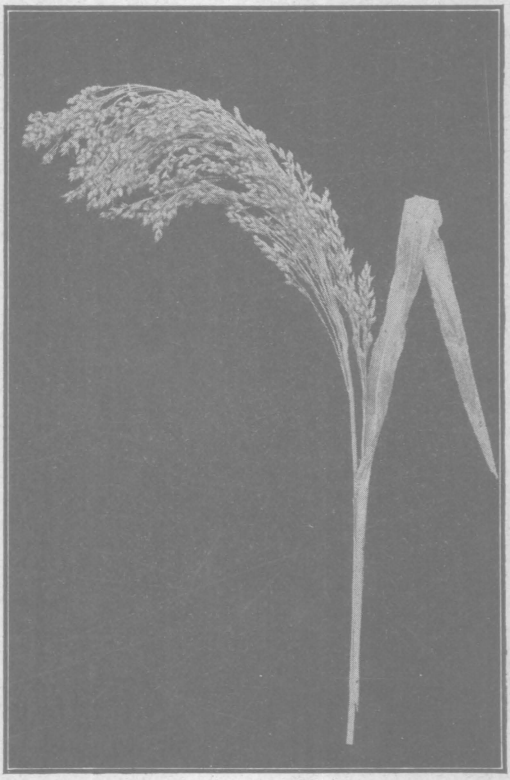

Fig. 10. Broom corn millet. One-third natural size.

Pearl millet Though technically not a millet, the coarse annual grass bearing cylindrical spikes, 6 to 12 inches long, resembling that of the cat-tail flag, is commonly spoken of as Pearl or Cat-tail millet, (Pennisetum spicatum.)

It suckers freely, and in the South, where length of season permits of two or more cuttings, it is highly prized as a soiling crop, yielding, it is said, as high as 40 tons of green or 16 tons of dry forage per acre.

In Ohio the seasons are too short for its full development. On the Station form it attains a height of 2 to 9 ft., but usually fails to come into full head.

Pencilaria, Horse millet and Mand's Wonder are a few of the many names under which it is frequently sold.

Sudan Grass: For the past two years, Sudan grass, a comparatively new introduction received from Prof. C. V. Piper, of the Bureau of Plant Industry, U. S. Department of Agriculture, has been included in the millet test of the Ohio Station, its cultural

requirements being similar to that of millet. Botanically, it is a close relative of sorghum, the original form of both being the well known, though sometimes troublesome, Johnson grass (sorghum halepense). Unlike the Johnson grass, however, it is strictly an annual, without rootstock, and has no weedy propensities. The inflorescence or head is a panicle like that of broom corn. The seeds are somewhat larger than are those of the broom corn millet and are reddish-brown in color. It is a vigorous growing plant having rather coarse forage (coarser than German millet) and at the Ohio Station attains a height of 3 to 5 feet. (Fig. 13.)

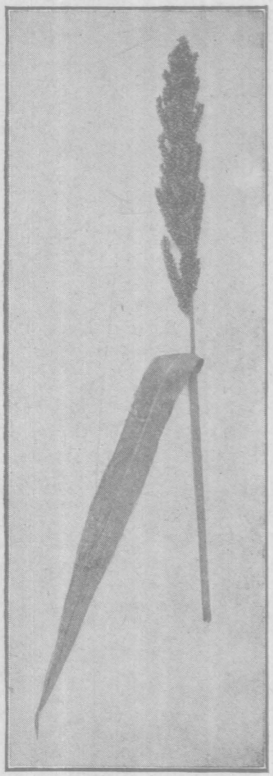

Fig. 11. Barnyard millet. One-fourth natural size.

As may be noted from Table VI, in yield of air dry forage it compares very favorably with millet, it being surpassed in 1913 by the Barnyard and German and in 1912 by the Barnyard only. Little is known as yet regarding its feeding value, though Professor Piper reports that at Chillicothe, Texas, "horses ate it readily and perfectly clean."

CULTURE

Soil and fertilizers: Millet may be grown with varying degrees of success on most any kind of land; but on rich, mellow soils it does best.

Like sorghum, and for the same reason, millet bears the reputation of being "hard on the land." However, the exhausted effect usually passes away in a short time.

Well-rotted stable manure or readily soluble commercial fertilizers are best with which to enrich poor land for the growing of millet.

Seeding: In order to keep ahead of the weeds, millet should have all the advantages afforded by the preparation of an excellent seed bed—clean, firm, fine and moist.

Like sorghum, millet should not be seeded until all danger of frost is past and continued warm weather is assured. In favorable

seasons, seedings of the earlier varieties, such as the Hungarian, may be made, with chances of fair success, as late as the middle or latter part of July.

Millet may be broadcasted and harrowed in, or drilled with an ordinary grain drill, covering not to exceed 1 to 1½ inch deep.

When drilled solid as for hay, soiling or pasture, from 3 to 4 pecks per acre is none too much of the foxtail millets—the best for these purposes. If less than 3 pecks is sown the forage is apt to be coarse and unpalatable. If sown for either seed or silage, it is usually seeded in rows 24 to 30 inches apart—far enough to permit cultivation—using from 1½ to 2 pecks per acre—one-half that required for forage of fine quality.

When drilled solid, Barnyard millet is seeded a little lighter than the foxtail group, usually at the rate of about two pecks per acre.

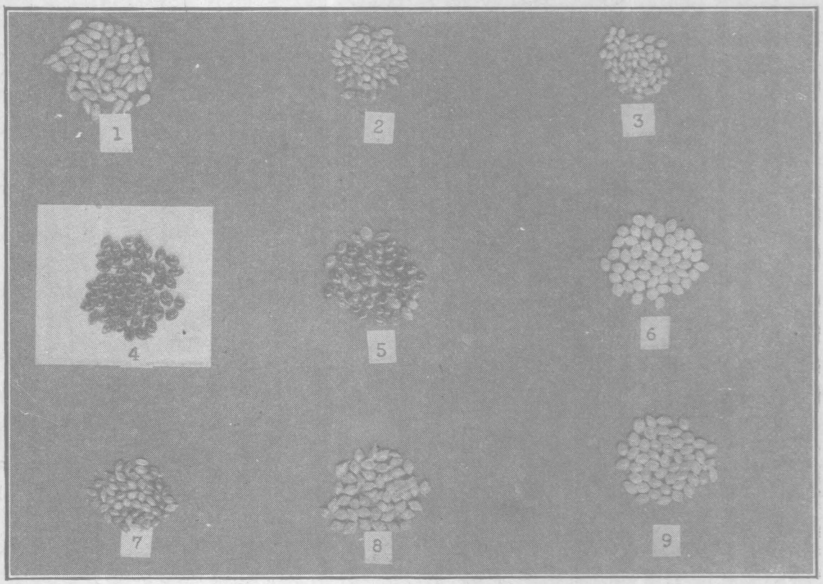

Fig. 12. Millet seeds. (1) Pearl, (2) Hungarian, (3) German, (4) Black Voronezh, (5) Early Fortune, (6) White French, (7) Red Siberian, (8) Barnyard, (9) Broom corn. Natural size.

HARVESTING

Hay: That some caution should be exercised in the feeding of millet hay has been shown by several experiment stations.[1] However, the danger is thought to be reduced to a minimum, if not quite eliminated, by cutting at what seems to be the most favorable time—when one-half or more of the plants are in head—and by feeding moderately and not too exclusively.

[1]N. D. Bul. No. 7. Mich. Bul. No. 117.

As millet approaches maturity it deteriorates as regards palatability and digestibility. Furthermore, the development of bristles may result in injury when fed to stock. It should never be allowed to stand until the seeds are ripe.

The hay is cured practically the same as timothy. After lying for a time in the swath it should be piled in cocks, where, on account of its coarseness, it will usually need to remain a little longer than timothy.

When properly cut and cured, millet hay slightly exceeds timothy, both as regards composition and digestibility.

Soiling. For soiling, millet may be harvested any time after it is large enough to handle, usually 40 to 50 days after planting. For this purpose the foxtail millets are best, though some have obtained good results from the use of the Barnyard.

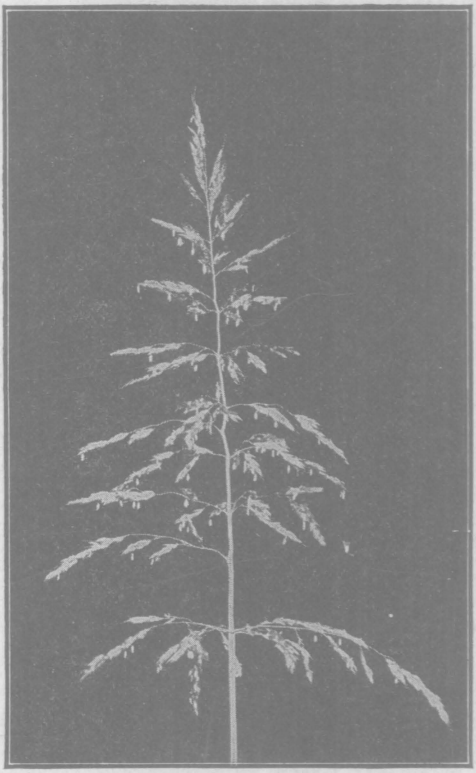

Fig. 13. Sudan grass.

Silage: Like corn, millet is most suitable for silage when the seed is in the dough stage.

Seed: When grown for seed, millet may be cut and threshed with the same implements that are usually employed in harvesting wheat and oats. The separator, however, should be so adjusted as to give lighter wind blast, and the use of finer riddles, preferably clover screens, is recommended.

So little seed is produced in Ohio that average yields, having significance, are hard to establish. In a favorable season a reasonable expectation is from 15 to 40 bushels per acre, depending upon the fertility of the soil.

The straw does not make very good forage. The hard, woody stems contain little nutrition and the beards are liable to collect in

the stomachs of animals. However, if well cared for and properly supplemented with grain, it can be made to answer for more valuable roughage.

Other cereal forage grasses of more or less merit in the production of forage are rye, wheat and oats.

RYE

Pasture: Not being a sod-forming plant, rye is not well adapted to pasturing, but in the absence of permanent pasture, or in order to avoid too early pasturing of blue grass, it is useful, as it will furnish green feed earlier than any other cereal or annual forage crop. Under favorable conditions it will be ready to pasture by the latter part of April. Unless intended for hogs it should not be allowed to come in head, as with age it loses its palatability. It is at its best when not over one foot in height.

Concerning rye, Prof. B. E. Carmichael, Chief in Animal Husbandry at this Station, writes:

"Rye has a high value for use as very early spring pasture, especially for sheep, which are not so likely to injure the soil and waste the green feed as are hogs. The latter may do considerable damage in early spring by trampling and by rooting. Rye may often be used to good advantage in late fall or during the winter, providing the condition of the soil does not prevent. It may be pastured in the spring by cattle with good results, but not so early as by sheep. The practice of hogging down mature rye has been highly regarded by some. Excepting in rare instances, this practice has but little to commend it, as the rye is worth no more per pound than corn, if quite as much, and, of course, yields far less.

"The growing of rye or rape, or both, in corn that is to be harvested by hogs, or on oats stubble, is in high favor with some on account of the considerable amount of valuable green feed that will be produced if the late summer season is favorable."

Silage: If occasion demands, rye may be put in the silo, though as compared with corn silage it is neither as palatable nor as nutritious, For this purpose it should be cut when heads are nicely out or not later than when in bloom, using an ordinary grain binder. On account of air in stems it should be packed thoroughly and this is greatly facilitated by setting the silage cutter to cut the stems short—about one-half inch.

Hay: Though not very palatable, chemically. rye hay compares favorably with that made from the leading perennial grasses. If cut when nicely in head, it makes fairly desirable hay and is eaten with moderate relish.

Under average conditions from 2 to 4 tons per acre of dry forage may be expected.

Cover crop: In the Ohio Station's work with cover crops, embracing 20 tests including 14 different plants and combinations thereof, thus far (4 years) rye has proved to be the most reliable. From the standpoint of fertility maintenance it is, of course, less desirable than legumes, but in the latitude of Wooster rye is more sure to go through the winter than any of the other crops tested. If possible to seed the latter part of July or the first of August, as in corn at time of last cultivation, rye and hairy vetch may be seeded together, using 4 or 5 pecks of the former and 20 to 30 pounds of the latter per acre.

WHEAT

While wheat is harvested almost exclusively as grain, yet, like rye, the green forage may be utilized as pasture, soiling, silage and hay.

Rank wheat, which is to be harvested for grain, may be pastured sparingly with hogs and sheep, providing the ground is not wet enough to poach, but such pasturing usually results in a slight reduction of yield, though in cases of excessive growth of straw it may result in a small increase of grain. Just when to pasture is difficult to determine as the after season has an important bearing upon the final outcome.

OATS

Pasture: Among the best spring crops for the production of early pasture are oats. As soon as they are 4 to 6 inches high—large enough to make a good mouthful—stock may be turned in. If desired, seed for permanent pasture may be sown with them and if pastured neither too heavily nor when the ground is too wet, little injury will result to the new seeding.

A slightly more desirable, and hence more satisfactory early spring pasture for cows and horses, is a mixture of oats, barley and rye—one bushel of oats and 3 pecks each of barley and rye per acre.

Though feasible, oats are in little demand for either soiling or silage purposes.

Hay: As a hay crop oats have several things to commend them. Pound for pound the hay is almost equal to clover and is superior to timothy. Clover is more likely to succeed when seeded in oats to be cut for hay rather than grain. Furthermore, it is an excellent crop with which to thicken a thin or old meadow. As soon as the weather will permit the oats may be disk-drilled in the thin clover

or timothy, using about 8 pecks per acre. Though oats and timothy do not mature together, yet, if cut at the proper time, the mixture makes hay of fair quality.

With reference to the best time to cut oats, there is considerable difference of opinion, but as the result of careful weighing and analyses of green oats cut at different stages of development, the South Carolina Station[1] concludes: "If a nitrogenous forage is desired, cut in the early milk stage when the whole plant is quite palatable; if a forage high in carbohydrates is desired, cut at the beginning of the dough stage; because, after this time, although there will be a continued increase in starch in the seed, the other parts are decreasing rapidly in feed value."

The value of oat hay depends somewhat upon the variety used, as among different varieties there is considerable variation both as regards quantity and quality of straw produced. In the five-year average of 36 varieties tested at the Ohio Station there was a difference in yield of straw per acre of 1,783 pounds.

Among the more leafy varieties having good quality of straw and, therefore, among the more acceptable for hay, are such as the Watson, Wideawake, Welcome and others.

Oats and field peas: Oats are frequently grown with field peas and the hay made from this mixture compares favorable with clover, not only in digestible nutrients but, also, when well cured, in palatability.

Adaptation: The culture of field peas is quite common throughout northern Ohio, but in the southern part of the state, where the temperature is somewhat higher, they are not at their best, though if seeded early, a fair crop may be expected.

Seeding: Both oats and field peas thrive best in cool weather and hence should be seeded as early in the spring as possible. The drill should be set—weighted if necessary—to put the peas in at least to a depth of 4 inches. If planted much shallower the peas are apt to dry up before maturity. The oats may be broadcasted or drilled at the same time (not the same operation) or, if the weather is favorable, a few days later, but before the peas begin to come up. If broadcasted, the oats should be harrowed in.

Three bushels per acre of this mixture is regarded as a good seeding, the proportion of each being varied to suit requirements. At the Ohio Station 3 combinations have been used, the results of which for 4 years are tabulated in Table VII.

[1]Bul. 163, p. 16.

TABLE VII. Oats and field peas. Pounds dry forage per acre.

Mixture of seed per acre	Year				4 year average	Protein	
	1909	1910	1911	1912		Percent	Lbs per acre
2 bus field peas—1 bu. oats	4 200	6,650	4,900	9,960	6 427	10 1	649 1
1½ bu field peas—1½ bu oats	4,800	7,350	4,800	9,040	6 497	9.5	617 2
1 bu. field peas—2 bus. oats.	4,240	7,400	4,800	10,340	6,695	9 0	602 5

From this table it may be noted that the highest yield of total forage came from the heaviest seeding of oats and that the yield decreases as the proportion of oats decreases. As might be expected, in yield of protein per acre the reverse is true. However, the difference in quantity of protein is not great enough to leave much margin after allowing for the greater cost of seed incident to the use of the larger quantities of peas.

Therefore it would seem that when total tonnage is the chief object, oats should predominate, and when the chief object is feed of high quality the peas should be in excess.

A common proportion is 1½ bushel per acre of each, and in view of the greater possibility of lodging from the heavier seeding of peas, it may be regarded as one of the most satisfactory.

Varieties: Several varieties of field peas are offered on the market, such as the White Canada, Scotch Beauty, Black-eyed Marrowfat, but the one in most common use is the White Canada. This variety matures well with any of the midseason varieties of oats.

ROOT CROPS

Root crops is a rather indefinite term applied to a group of plants, chiefly biennials, having similar uses and adaptations and usually characterized by an enlargement of the primary root and stem.

Though they carry a small percentage of dry matter, they are an excellent source of succulent food possessing high dietetic value.

So far as climatic conditions are concerned, root crops may be grown successfully throughout Ohio, but their culture is restricted by the rather limited conditions under which they can be utilized with profit, either as stock food or as a soil renovator.

As more and better succulent food can be produced cheaper with corn than with root crops, the growing of the latter for stock food is confined largely to the smaller farmers, the size of whose herds is such as not to warrant the erection of a silo.

Also, poultrymen, and dairy men who are feeding to make milk records, find it profitable to grow a few root crops.

As a soil renovator, root crops are of value in localities having heavy, clay soils as in many parts of northeastern Ohio. The ready access of air and water made possible by the decay of the roots of such crops has a beneficial effect upon tenacious soils.

Though the growing of root crops is not a prominent line of activity in Ohio agriculture, for the benefit of those who find them profitable, information regarding the culture of those most important in the state follows:

MANGELS

Soil and fertilization: A deep, rich, well drained loam is most desirable, though satisfactory crops may, with proper fertilization, be grown on the less productive clays and sands.

They call for practically the same fertilization as corn. Like the latter they can make good use of phosphated manure—8 to 10 tons per acre being a good application. One hundred pounds of muriate of potash can likely be used with profit on most soils, as the crop is a heavy consumer of potassium. On land deficient in nitrogen—a condition indicated by lack of dark green color in leaves —80 to 100 pounds per acre of nitrate of soda will likely pay well.

Seed bed: Since the germination of the seed and the early growth of the plants are very slow, a seed bed of good tilth and free from weeds is important else the young plants may be overwhelmed by the latter. The nature of the roots calls for rather deep plowing and, where the topography and texture of the soil permits, this work may well be done in the fall, the manure, if any, being plowed under.

Seeding: Mangels are usually seeded from May 1 to 20, in rows 28 to 36 inches apart, using 5 to 10 pounds of seed per acre. They should be covered not to exceed three-fourths inch deep.

They may be planted with a hand drill or, by closing a part of the hoes, a grain drill can be adapted to this work.

Cultivation: Before the rows become visible, cultivation should begin, using such implements as a light harrow or weeder. After the plants are large enough so that the rows may be followed easily, cultivation with the ordinary sorts of implements should be frequent and should continue for 6 to 10 weeks, or until the tops cover the ground.

At the time the plants have about four leaves the process of blocking and thinning begins. Blocking consists in removing with a hoe all the plants in the row except little bunches 6 to 10 inches apart, the distance depending upon the variety. Immediately

thereafter the bunches should be thinned by hand to one plant. The hand thinning is very important and at the same time it is the most expensive and most laborious work connected with the culture of mangels.

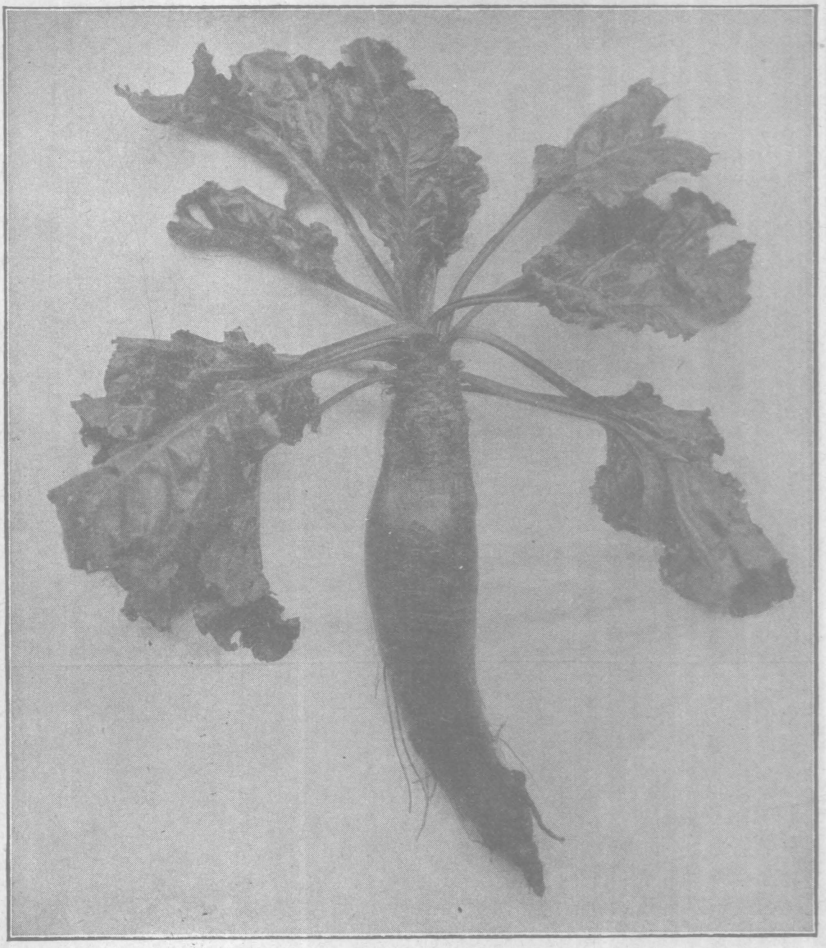

Fig. 14. Mangel (Long-red.) About one-sixth natural size.

Harvesting: Harvesting embraces three distinct operations—lifting, pulling and topping. Lifting consists simply in loosening the mangels—an act accomplished either by cutting a single furrow with a small plow on one side of the row or by the use of a double-pointed plow so constructed that a point passes on either side of the row.

The pulling and topping are usually done by hand, after which the mangels are thrown into piles.

Storing: In the absence of a root cellar, mangels may be "pitted" by throwing into ricks and covering with alternate layers of straw and earth, adding a layer of earth as the severity of the weather increases. In locating the pit an elevated site should be selected in order to provide good drainage.

Yield: The range in yield of mangels is large, varying from 15 to 40 tons. On the Station farm in 1911 they yielded at the rate of 21½ tons per acre.

Feeding: For most livestock mangels are cut into small pieces or sliced, though for poultry this is unnecessary. For a thousand-pound animal 25 to 50 pounds per day is regarded as a good feed; the amount depending upon the quantity of other feeds used.

Varieties: Mangels are usually classified with respect to shape, the chief forms being long, intermediate, tankard and globe. In color of flesh they may be white, pink, red, yellow, golden and purple or black. Varieties are often designated by coupling the names used to describe the mangels with respect to form and color, as Long Red, Golden Tankard, Yellow Globe, etc. (Fig. 14.)

In the long form the length of root (sometimes 20 or more inches) exceeds that of the breadth 3 to 4 times and one-half or more of the root may be below the surface of the ground, thus the successful culture of this type is restricted to deep soils. As may be inferred from the names, all the other forms of mangels have shorter roots and consequently are adapted to shallower soils, the globe type being especially suited to the lighter types of land.

The half-sugar mangel, said to be a cross between the sugar beet and mangel, is regarded as one of the best for stock food.

SUGAR BEETS

Sugar beets are mangels highly developed along the line of sugar production. Aside from composition they have come to differ from mangels with respect to size, shape, color, depth of growth and in keeping qualities. Sugar beets are smaller than mangels (fig. 15), usually conical (Vilmorin's Improved) or pear shaped (Klein Wanzlebener); rarely other than white in color; they grow entirely beneath the surface of the ground, consequently are difficult to harvest, and are less adapted than mangels for late storage in spring.

As the yield per acre is less and the cost of harvesting is greater than that of mangels, the latter are more satisfactory as a source of succulent feed.

On the Station farm in 1911 they yielded at the rate of 12½ tons per acre.

The culture of sugar beets is essentially the same as that of mangels. The former, however, are usually seeded thicker than the latter; the usual rate per acre for sugar beets being 15 to 20 pounds, and in rows 18 to 24 inches apart.

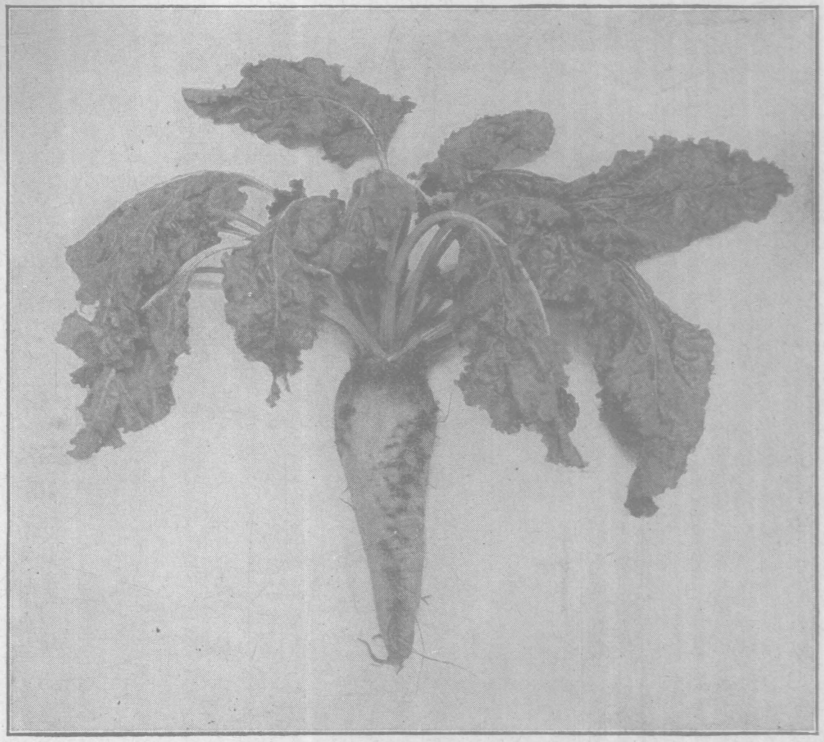

Fig. 15. Sugar beet.

For the production of sugar, the culture of beets is restricted to a comparatively cool climate; such as that which predominates throughout the region of the northern limit of the corn belt. In warmer climates they are not only more subject to disease but often the content of sugar is too low for profitable production.

TURNIPS

Adaptation: With respect to soil, turnips thrive best on silt loams; stiff clay and sandy soils not being well suited, the former on account of the difficulty with which a finely pulverized seed bed is prepared, the latter on account of incapacity to hold moisture. Like mangels, turnips thrive best on a calcareous soil. Not a great amount of sunshine is required, a cool, damp climate being favorable.

Culture: In preparation of seed bed, cultivation, harvesting and storing, practically the same operations employed in the culture of mangels apply in the growing of turnips. However, in the earlier stages of growth turnips grow more rapidly, hence less difficulty is experienced in keeping the seed bed clean while the plants are young.

They may be seeded successfully at any time from the first of May to August. With a hand garden-drill they may be seeded in rows 18 to 30 inches apart, using from 2 to 5, usually 3 pounds, of seed per acre. Seeded broadcast, a little more seed is required, the usual amount ranging from 4 to 6 pounds.

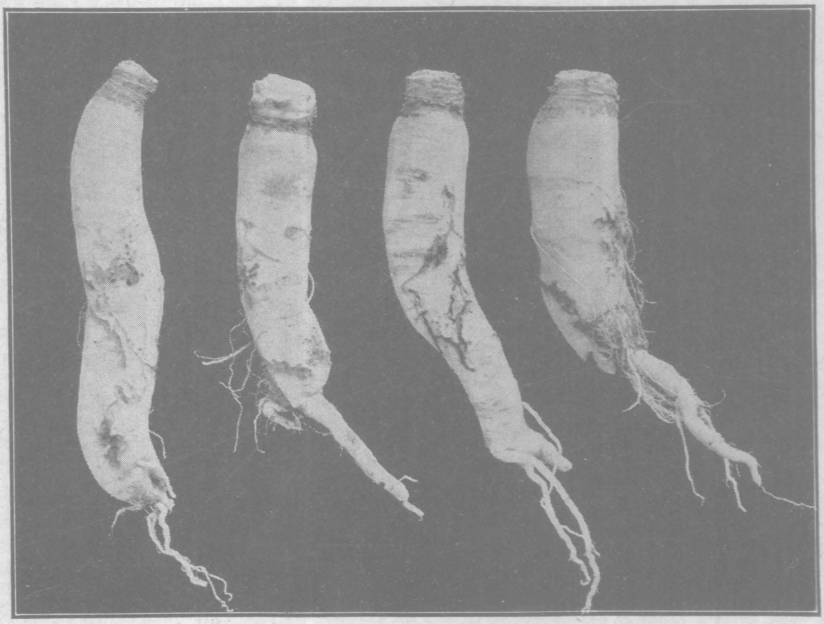

Fig. 16. Cowhorn turnips.

Turnips are often seeded in corn at the time of last cultivation, both for the purpose of furnishing fall feed and, on some types of land, especially heavy clays, for the effect on the texture of the soil. If the height of the corn interferes with the proper distribution of seed on foot, in the experience of the Ohio Station it has been found practicable to broadcast it on horseback, care being taken to cover the ears of the horse with small bags. The seed may be covered with a light cultivator. One-half to three-fourths inch is about the proper depth to cover turnip seed.

Yield: Turnips yield less than mangels, 10 to 25 tons per acre being regarded as fair yields.

Varieties: Turnips are usually classified with respect to either form or color of flesh.

With reference to form, a common grouping is long, tankard or spindle shaped, round or globe and flat, the name in each case indicating the shape. The form of the upper part is sometimes further described as "flat topped" or "round topped"; the latter being preferable as it is less subject to decay.

In the long varieties the length exceeds the breadth by three or more times. A common form of this type, and one of the most valuable as a catch crop, is the Cowhorn. (Fig. 16.)

With reference to color, turnips are frequently grouped as white-fleshed or yellow-fleshed. On the basis of the color of the upper or exposed part, they are further subdivided, the white-fleshed varieties as "white tops," "green tops," "purple or red tops" (Fig 17), and "gray stones," a mottled appearance produced by transverse streaks of green and purple; the yellow-fleshed varieties as "yellow tops," "green tops" and "purple tops."

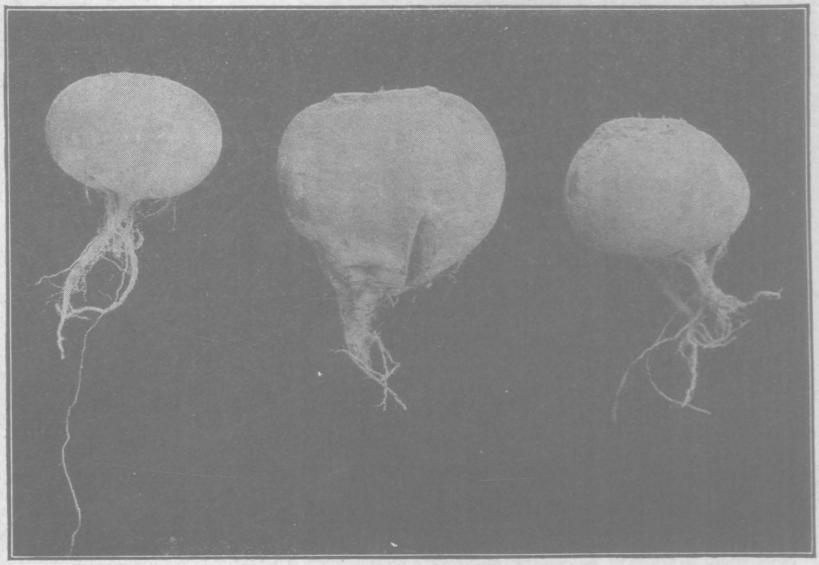

Fig. 17. Purple top turnips.

The white-fleshed varie ies are characterized by rapidity of growth, soft flesn, low feeding value and little resistance to frost. They are best suited to fall and early winter feeding. This class of turnips is usually seeded broadcast, it being considered of too little value to sow in rows and cultivate.

As compared with the white-fleshed varieties, the yellow-fleshed grow less rapidly, are firmer, have higher feeding value, are more resistant to frost and may be kept sound for a much longer period of time.

RAPE

Classification and adaptation: Though not looked upon as a root crop, botanically rape is a close relative of mangels and turnips, all being members of a well known and populous group—the mustard family.

Fig. 18. Rape, drilled in rows; 59 days after seeding.

The soil and climatic adaptation of rape is similar to that of turnips. It is partial to rich loams and, like corn, it responds readily to liberal applications of stable manure and fertilizers.

It calls for the preparation of an excellent seed bed; one which is firm, fine and moist.

Seeding: The usual time of seeding is from April to July 15, though in some years the weather permits of successful seeding as early as the latter part of March. As a catch crop it may be seeded in corn at the time of last cultivation and in the same manner as turnips.

It may be sown solid (broadcasted or drilled) or in rows 24 to 28 inches apart. For seeding in rows a hand drill may be adjusted or a grain drill may be adapted by closing a part of the hoes. The

seed is best distributed from the grass-seeding attachment of a drill, piping the seed through the hoes, setting the drill to cover it completely though not deep. If broadcasted, 5 to 8 pounds of seed per acre are required; if drilled in rows, 2 to 3 pounds are sufficient.

Cultivation: Seeding in rows permits of cultivation which results in a more rapid growth and, during the pasturing season, less is wasted by trampling. (Fig. 18.)

Unlike mangels, rape grows rapidly from the first, and if given about three cultivations at intervals of one week, it should be ready to pasture in 6 to 10 weeks.

Regarding the value of rape as a forage plant, Prof. B. E. Carmichael writes:

"Rape has proved a very valuable source of green feed for both sheep and swine at the Ohio Station. Sheep and lambs will do well on rape with no grain. Young hogs, or, indeed, hogs of any age that are expected to yield rapid gains, should be provided with a fairly liberal grain ration in connection with rape pasture. On account of the large proportion of crude protein in rape, there is much less need for nitrogenous supplements in connection with corn and rape than with corn in dry lot. Bulletin 242 gives the results of a number of experiments in which use was made of rape for swine."

If not pastured too closely, rape will continue to furnish green forage throughout the season, the amount varying with the fertility of the soil.

Varieties: While there are numerous types of rape, including many hybrids and crosses, yet all may be grouped in two classes: annual or summer, and biennial or winter rape.

From the seed, an oil is extracted which is used for lubricating and lighting and the refuse or "rape cake" is highly prized as stock food and fertilizer.

The biennial or winter rape, of which the Dwarf Essex is a leading variety, is the kind commonly grown in this country for forage. This type produces seed only in localities where it can withstand the winter. Most of the seed used in this country is imported from Europe.